



Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

TRIUMF Report
CINP-IPP Joint Session
June 12, 2016

Jonathan Bagger
Director

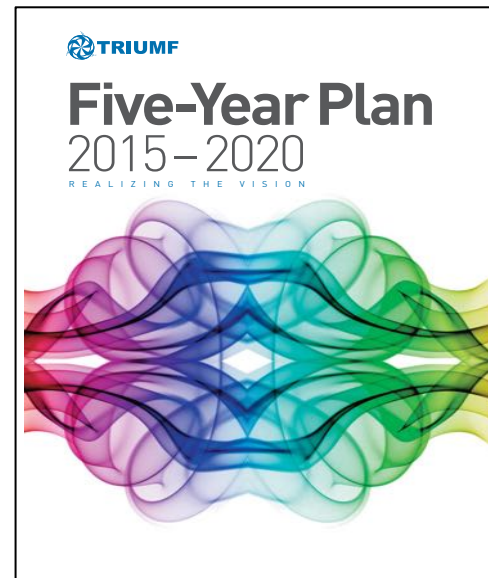




Le laboratoire est en bon état!

- As we enter Year 2 of the Five-Year Plan, TRIUMF's priorities remain unchanged
 - ARIEL II
 - Nuclear and Particle Physics
 - Nuclear Medicine
 - Materials Science
 - Commercialization ...
- ... all in the context of

Safe and Effective Operations



1. Operate the laboratory safely and effectively
2. Produce world-class science
3. Connect TRIUMF to the world



1. Operate the laboratory safely and effectively
2. Produce world-class science
3. Connect TRIUMF to the world

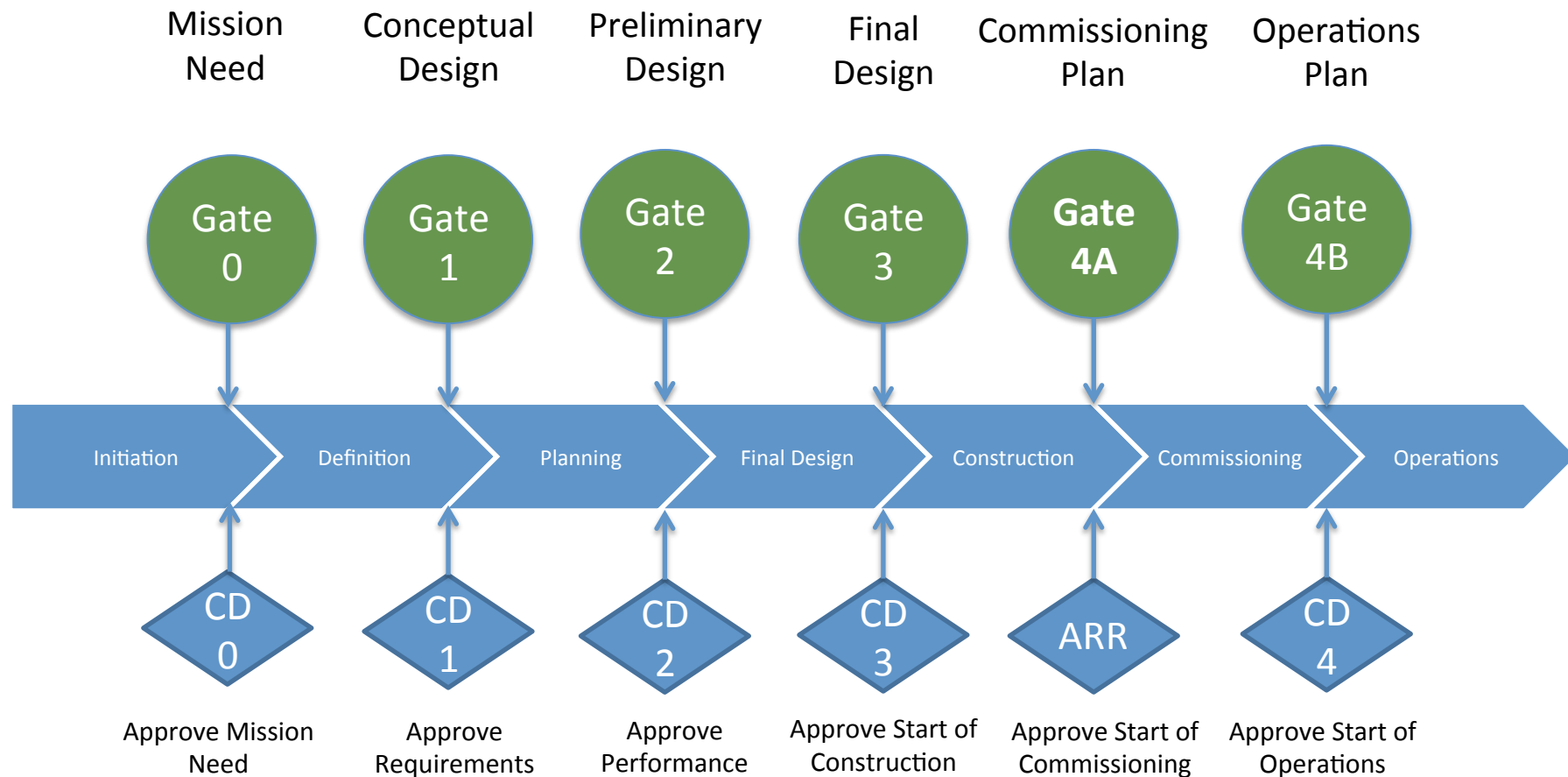




Safety and security improvements

- Safety training
 - Building access training, supervisor safety training, basic radiation training improved and implemented
- ANSI-compliant site-wide signage
 - Emergency preparedness and fire safety signage complete
 - Safety signage finalized for order
 - Facility signage underway
- Personnel safety systems
 - Exclusion Area Access Control Systems upgraded
- New visitor application





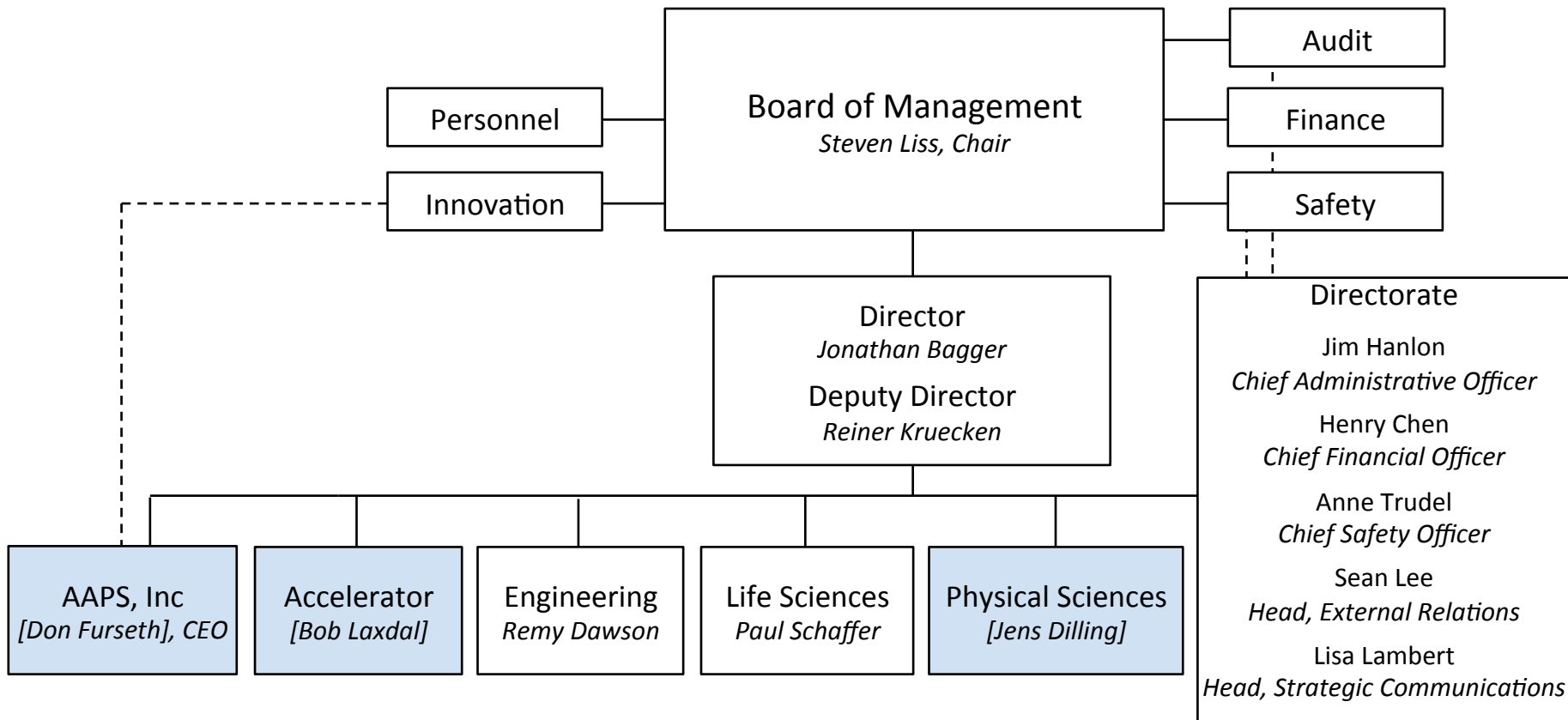
	Gate 0	Gate 1	Gate 2	Gate 3
ARIEL-I	N/A	✓	✓	
UCN	N/A	✓	✓	
EMMA	N/A	✓		
IRIS	N/A	✓	✓	✓
GRIFFIN	N/A	✓	✓	
DESCANT	N/A	✓	✓	
Francium Trapping Facility	N/A	✓	✓	✓
He Liquefier	N/A	✓	✓	
ATLAS NSW/LAr Upgrades	N/A	✓	✓	
ALPHA-g	N/A	✓	TBD	
Super-CDMS	N/A	✓	✓	

	Gate 0	Gate 1	Gate 2	Gate 3
ARIEL-II	✓	✓	[9/16]	
ARIEL 1.5	✓	✓	✓	
ATLAS Phase 2 Upgrade	✓	5/16		
HL-LHC Accelerator	✓	TBD		
Photodetector Infrastruc.	✓	TBD		
HyperK/PINGU	✓	5/16		
UCN/nEDM	✓	6/16		
MOLLER	✓	7/16		
TIGRESS Si Tracker	✓	TBD		
Muon Beamline Upgrade		6/16		
Isotope Harvesting	[✓]	6/16		
ARIEL 2 nd RIB Accelerator	✗	N/A		

CFI projects reviewed by mini-PPAC in December, 2015

2016 Shutdown

- Cyclotron Refurbishing
 - ✓ Main magnet power supply replacement – identified as top candidate in risk assessment matrix – ordered – install 2017 shutdown
 - ✓ Mechanical tuners for cyclotron rf resonators – 60 assembled – 15 installed
 - ✓ Centre region correction plate power supplies – 38 replaced
 - ✓ Oxygen Deficiency Monitoring System in the cyclotron vault – installed
 - ✓ New LN2 supply manifold with safety automatic shut-off valves – completed
- BL1A
 - ✓ T1/T2 BL1A targets water package PLC controls – completed
 - ✓ New 90 kW power supply for BL1A Q15 quadrupole – completed
- BL4V
 - ✓ Significant opportunistic removal of vault beamline to prepare for ARIEL II



Leadership Searches:

1. Associate Laboratory Director, Accelerator Division

- Search Committee: Steve Holmes, Fermilab (Chair); Rick Baartman, TRIUMF; Yuri Bylinski, TRIUMF; Sytze Brandenburg, KVI; Kathy Harkay, Argonne; Reiner Kruecken, TRIUMF; Mike Seidel, PSI

2. Associate Laboratory Director, Physical Sciences Division

- Search Committee: Mike Roney, UVic (Chair); Makoto Fujiwara, TRIUMF; Rituparna Kanungo, Saint Mary's; Alison Laird, York; Bob Laxdal, TRIUMF; Graeme Luke, McMaster, Paul Mantica, Michigan State; Brigitte Vachon, McGill

3. Advanced Applied Physics Solutions, President and CEO

- Search Committee: Jonathan Bagger, TRIUMF (Chair); Jim Hanlon, TRIUMF; Eric Guetre, TRIUMF; Haig Farris, Fractal Capital; Karimah Es Sabar, CDRD; Assisted by Korn Ferry

ALD – Accelerator Division

– Oliver Kester

- Start date: September, 2016
- Currently Director, FAIR@GSI and Professor, Goethe University Frankfurt
- Previously at LMU Munich, Michigan State University, CERN
- PhD: Goethe University Frankfurt



BAE Hires

- Beatrice Franke, UCN
 - Start date: Summer, 2016
 - Currently postdoc at MPQ Munich
 - PhD: ETH Zurich

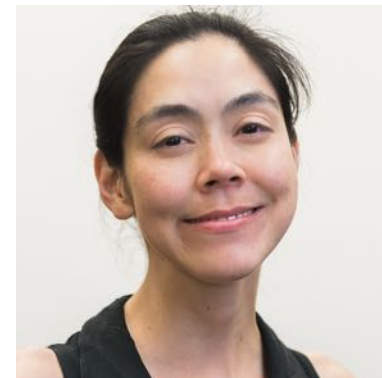
- Nigel Hessey, ATLAS
 - Start date: Summer, 2016
 - Currently senior staff at NIKHEF, Amsterdam
 - Former ATLAS upgrade coordinator
 - PhD: University of Birmingham



BAE Hires

- Ania Kwiatkowski, ISAC
 - Start date: Summer, 2016
 - Currently faculty at Texas A&M University
 - PhD: Michigan State University

- Valery Radchenko, Radiochemistry
 - Start date: Summer, 2016
 - Currently at postdoc at Los Alamos National Laboratory
 - PhD: University of Mainz



Joint Hires

- Russell Memmei, Winnipeg
 - Start date: Summer, 2015
 - Previously postdoc at Winnipeg and Jefferson Lab
 - PhD: Virginia Tech



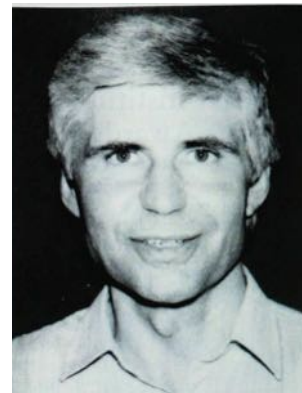
- Overall staff: 15% female
 - BAE 11%
 - P&S 23%
 - TEC 8%
 - Admin 71%
 - Non-Admin 9%
 - Postdocs 23%



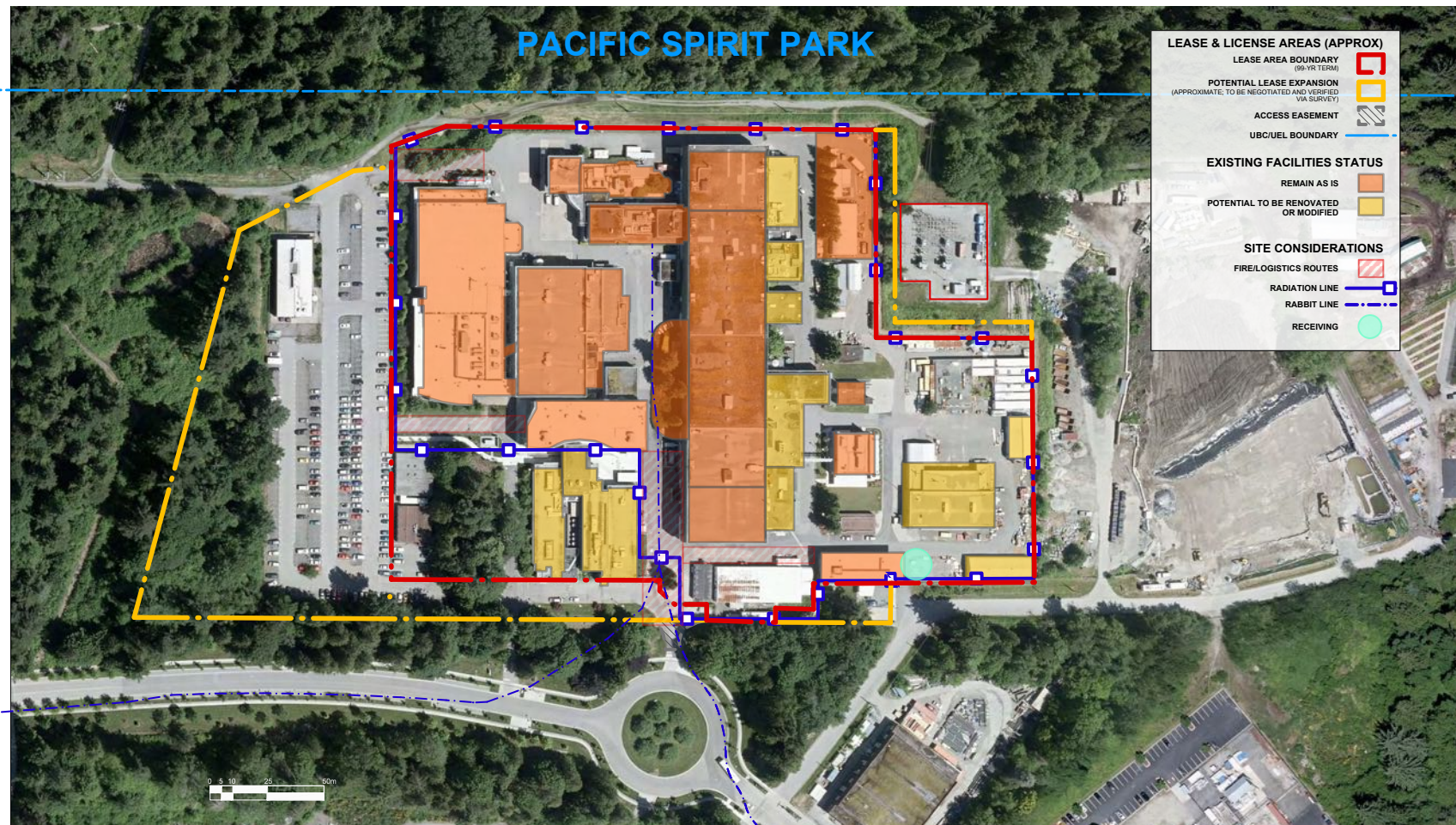
Goal: Build a laboratory that looks like Canada

- New Postdoctoral Fellowships!
 - Otto Hauser Postdoctoral Fellowship
 - Launching this summer
 - Proposed Harriet Brooks Postdoctoral Fellowship
 - Seeking funding

Watch for announcements!



- TRIUMF is working with UBC Campus Planning to develop a Site Master Plan that opens TRIUMF to the community, and
 - 1) Captures the present state of the laboratory
 - 2) Identifies facilities that need replacement and/or renovation
 - 3) Rationalizes the flow of people and materials across the site
 - 4) Links TRIUMF's site to its strategic plan
 - 5) Sites future facilities in support of the plan
 - 6) Allows TRIUMF to respond quickly if funding opportunities arise
 - 7) Identifies opportunities for philanthropy; makes TRIUMF's story easier to tell
 - 8) Ensures that growth occurs in a way that leaves room for future development





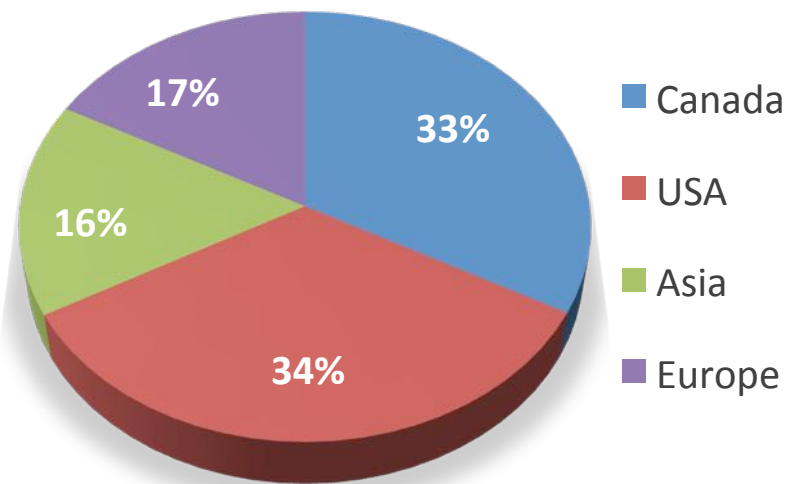




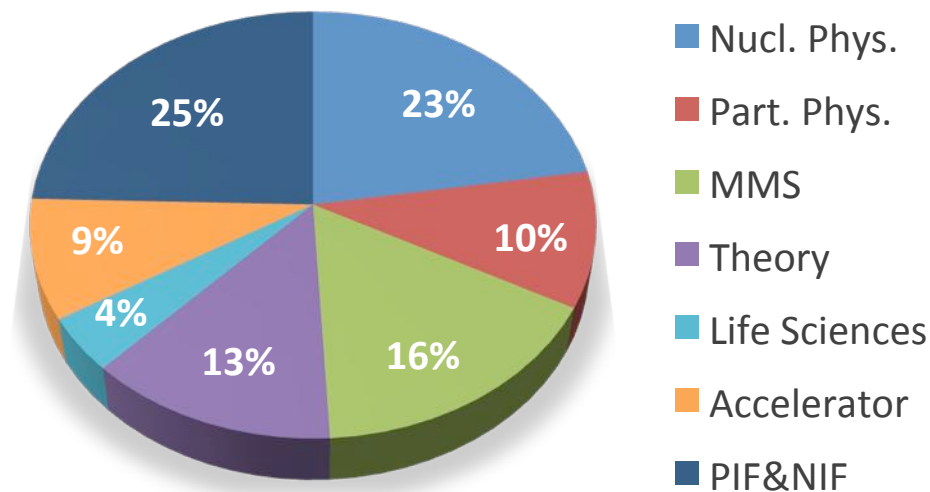
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Scientific Visitors & Users by Region (574)



Scientific Visitors & Users by Field (574)

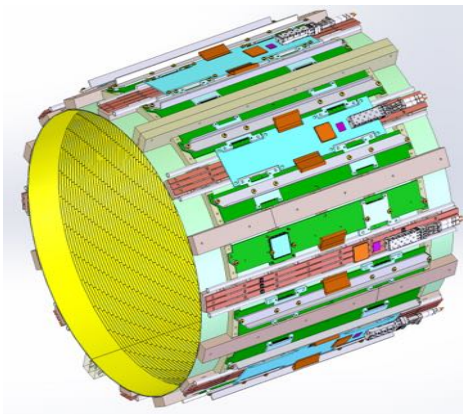
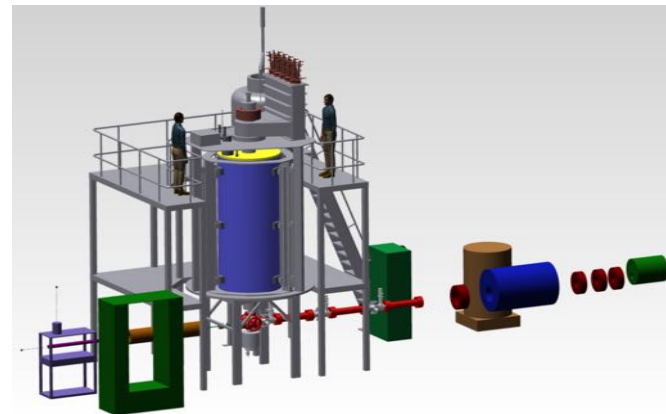




An improved limit on the charge of antihydrogen from stochastic acceleration

M. Ahmadi¹, M. Baquero-Ruiz^{2,3}, W. Bertse^{4,5}, E. Butler^{6,7}, A. Capra⁸, C. Carruth², C. L. Cesar⁹, M. Charlton¹⁰, A. E. Charman², S. Eriksson¹⁰, L. T. Evans², N. Evetts¹¹, J. Fajans², T. Friesen¹², M. C. Fujiwara¹³, D. R. Gill¹³, A. Gutierrez¹¹, J. S. Hangst¹², W. N. Hardy¹¹, M. E. Hayden¹⁴, C. A. Isaac¹⁰, A. Ishida⁷, S. A. Jones¹⁰, S. Jonsell¹⁵, L. Kurchaninov¹³, N. Madsen¹⁰, D. Maxwell¹⁰, J. T. K. McKenna¹³, S. Menary⁸, J. M. Michan¹³, T. Momose¹⁶, J. J. Munich¹⁴, P. Nolan¹, K. Olchanski¹³, A. Olin^{13,17}, A. Povilus², P. Pusa¹, C. Ø. Rasmussen¹², F. Robicheaux¹⁸, R. L. Sacramento⁹, M. Sameed¹⁰, E. Sarid¹⁹, D. M. Silveira⁹, C. So², T. D. Tharp¹², R. I. Thompson²⁰, D. P. van der Werf¹⁰, J. S. Wurtele^{2,21} & A. I. Zhmoginov²

- First results from ALPHA-2
 - Anti-H neutrality tested to 10^{-9}
 - New measure of e^+ charge to 10^{-9}
 - 40 x improvement over PDG



PRL **116**, 132701 (2016)

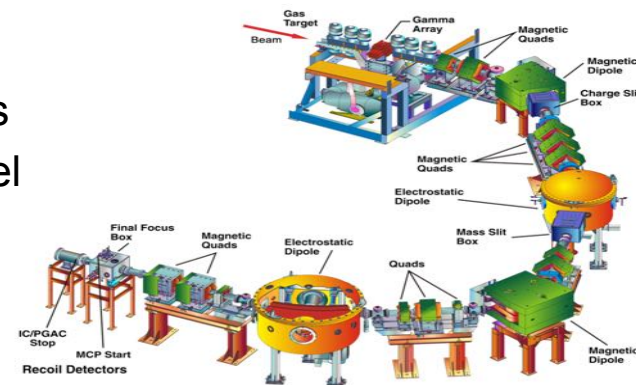
PHYSICAL REVIEW LETTERS

week ending
1 APRIL 2016

Direct Measurement of the Astrophysical $^{38}\text{K}(p,\gamma)^{39}\text{Ca}$ Reaction and Its Influence on the Production of Nuclides toward the End Point of Nova Nucleosynthesis

G. Lotay,^{1,2,*} G. Christian,^{3,†} C. Ruiz,³ C. Akers,^{3,4,‡} D. S. Burke,⁵ W. N. Catford,¹ A. A. Chen,⁵ D. Connolly,⁶ B. Davids,³ J. Fallis,³ U. Hager,^{6,§} D. A. Hutcheon,³ A. Mahl,⁶ A. Rojas,³ and X. Sun^{3,7}

- Ca, K, Ar are observed in expanding classical nova shells
- Observed abundances of Ca and Ar greatly exceed model predictions
- $^{38}\text{gK}(p,\gamma)^{39}\text{Ca}$ reaction uncertainty affects predicted Ar-K-Ca abundances by factors 25, 136, 58, respectively.

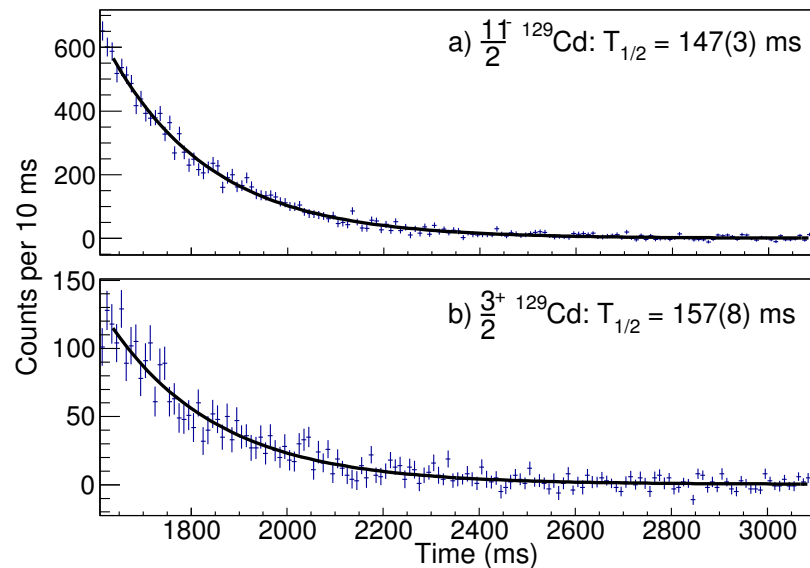


DRAGON measurement reduces uncertainty by a factor of 10

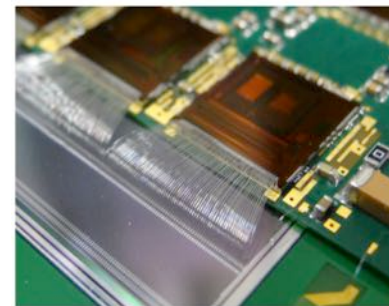
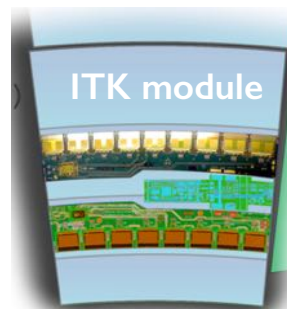
Half-Lives of Neutron-Rich $^{128-130}\text{Cd}$

R. Dunlop,^{1,*} V. Bildstein,¹ I. Dillmann,^{2,3,†} A. Jungclaus,⁴ C. E. Svensson,¹ C. Andreoiu,⁵ G. C. Ball,² N. Bernier,^{2,6} H. Bidaman,¹ P. Boubel,¹ C. Burbadge,¹ R. Caballero-Folch,² M. R. Dunlop,¹ L. J. Evitts,^{2,7} F. Garcia,⁵ A. B. Garnsworthy,² P. E. Garrett,¹ G. Hackman,² S. Hallam,^{2,7} J. Henderson,² S. Ilyushkin,⁸ Kisliuk,¹ R. Krücken,^{2,6} J. Lassen,^{2,9} R. Li,² E. MacConnachie,² A. D. MacLean,¹ E. McGee,¹ M. Moukaddam,² B. Olaizola,¹ E. Padilla-Rodal,¹⁰ J. Park,^{2,6} O. Paetkau,² C. M. Petrache,¹¹ J. L. Pore,⁵ A. J. Radich,¹ P. Ruotsalainen,² J. Smallcombe,² J. K. Smith,² S. L. Tabor,¹² A. Teigelhöfer,^{2,9} J. Turko,¹ and T. Zidar¹

- Half-lives of neutron rich isotopes are essential to understand contributions to r process induced by neutron star mergers
- Controversy in the literature regarding rates for $^{128-130}\text{Cd}$
- Resolved by GRIFFIN! First paper, accepted by PRC. First author, R. Dunlop, Guelph PhD student!



- 13 TeV operations have resumed!
- TRIUMF is supporting ATLAS and its upgrades
 - Phase 1 2019-2020
 - NSW and LAr Electronics
 - Phase 2 2024-2026
 - ITK and LAr Electronics
- TRIUMF will facilitate Canada's contribution to the LHC accelerator
- TRIUMF is committed to operating the ATLAS Tier-1 Centre
 - Moving to Compute Canada facility at SFU



- EMMA status
 - On track for commissioning in 2016.
First RIB experiments in spring 2017
 - All major components received from vendors
 - Focal plane detectors built and tested
 - Beam line leading to EMMA complete
 - Electrode assemblies being installed in vacuum tank
- EMMA Collaboration Meeting and International Workshop
 - July 19th, 2016, during TRIUMF's Science Week



April 28: D2O Cryostat installed above BL1U Target



D2O Cryostat Installed



2016 CAP-TRIUMF Vogt Medal

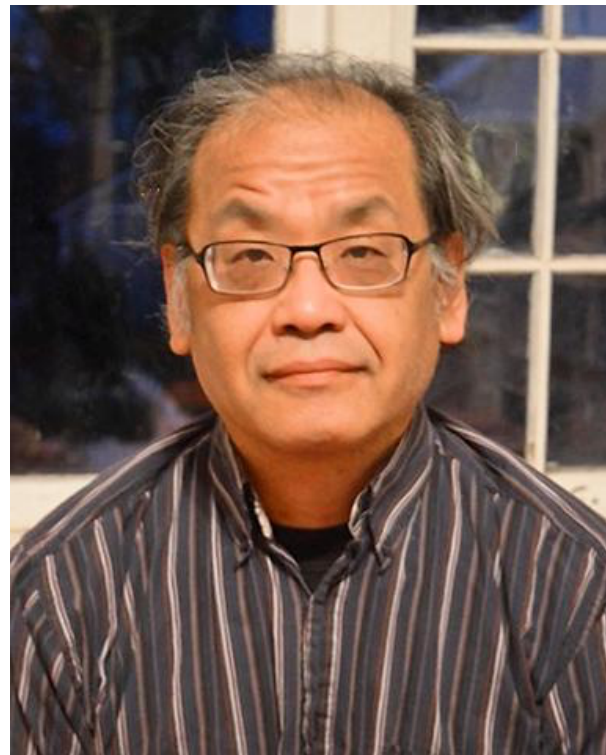
Awarded to Akira Konaka

“... for his outstanding contributions to the T2K long-baseline neutrino experiment, including his leadership in establishing the collaboration”



Canadian Association of Physicists

SUPPORTING PHYSICS RESEARCH AND EDUCATION IN CANADA



Thesis Prize, CAP Division of Nuclear Physics

“Probing Trapped Antihydrogen: In Situ Diagnostics and Observations of Quantum Transitions”

Tim Friensen
Calgary



Canadian Association of Physicists

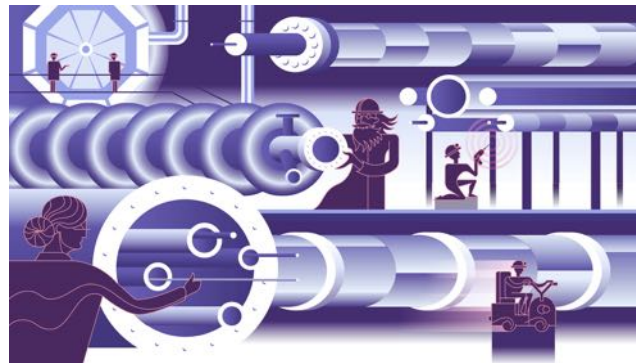
SUPPORTING PHYSICS RESEARCH AND EDUCATION IN CANADA

Supervisors: Rob Thompson and Makoto Fujiwara, ALPHA Collaboration

Graduate Student Program

- TRIUMF offers a unique-in-Canada graduate student program in Accelerator Physics and Engineering
- One course per year taught by TRIUMF research scientists – goal is to expand student pool across Canada
- 16 grad students registered in Accelerator Science program (U Manitoba, SFU, UBC, UVic)
 - 5 – SRF/RF
 - 2 – Beam physics
 - 9 – Targets/ion sources

symmetry
dimensions of particle physics



The hottest job in physics?

While the supply of accelerator physicists in the United States has grown modestly over the last decade, it hasn't been able to catch up with demand fueled by industry interest in medical particle accelerators and growing collaborations at the national labs.

SiC Nano Fibre Target R&D. John Wong, UBC MSc in Applied Science

- Higher yields for short-lived isotopes due to smaller diffusion lengths
- Stabilization of material structure, reduced aging effect
 - ❖ Collaboration with UBC Department of Material Engineering
 - ❖ Test experiment approved by EEC
 - ❖ SiC and electrospinning chosen for first test
 - ❖ Material production started



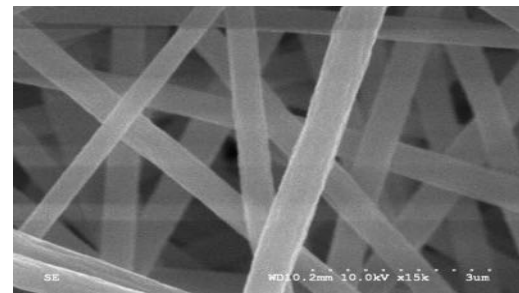
pristine



thermo stabilized



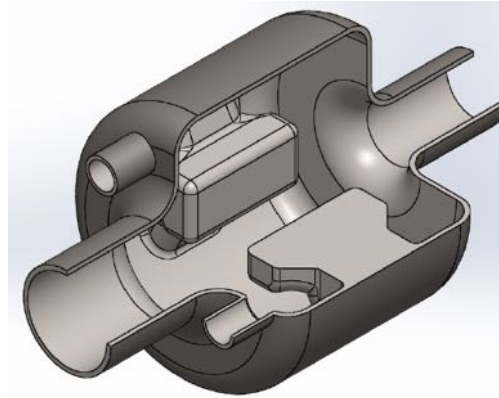
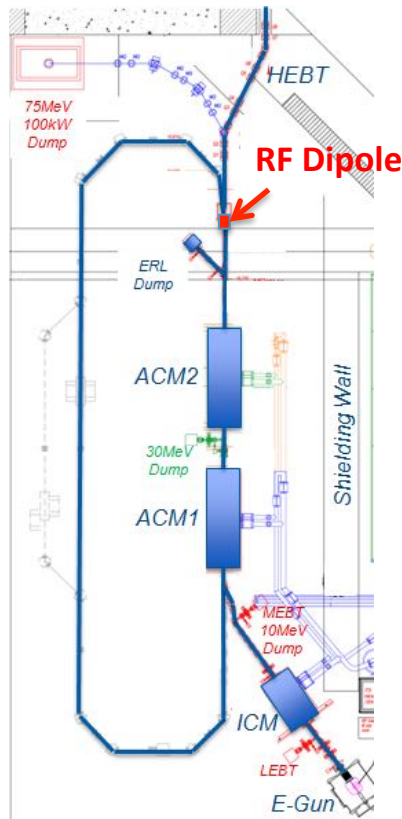
carbonized



SEM of carbonized mat

SRF Dipole Cavity R&D. Doug Storey, UVic PhD in Physics

- Will require an RF dipole to time share ERL mode with single pass beam
- 650MHz rf deflecting mode cavity has been designed
- Copper full scale model produced for rf tests and fabrication study
- SRF Cavity to be made from reactor grade Niobium with TIG welding and heat treated in induction furnace

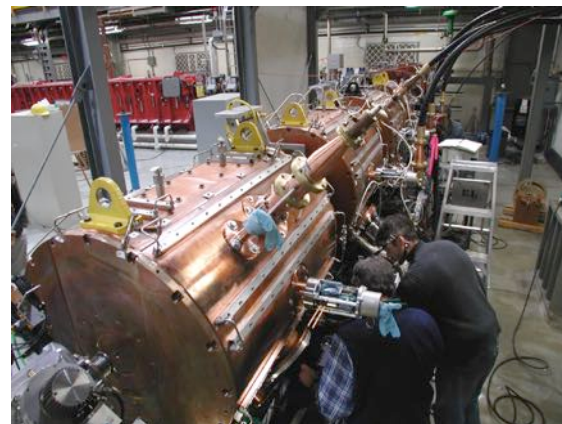
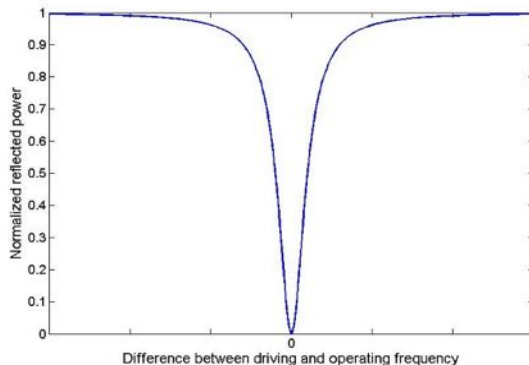
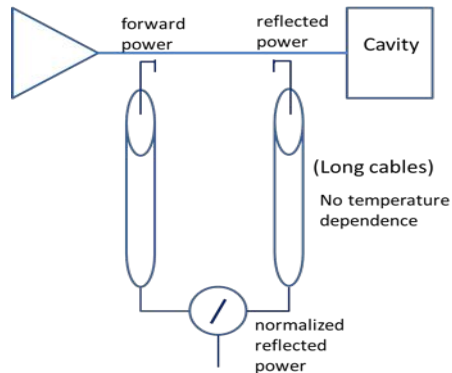


Copper Full Scale Model

Novel LLRF Control Algorithm. Ramona Leewe, SFU PhD in Applied Science

- LLRF control algorithms typically use the phase shift across the cavity to provide a signal for tuning – these signals are prone to drift
- A new algorithm has been employed that looks at the normalized reflected power using a sliding mode extremum-seeking optimization

The method has been successfully employed to control Tanks 4 and 5 on the ISAC Drift Tube Linac

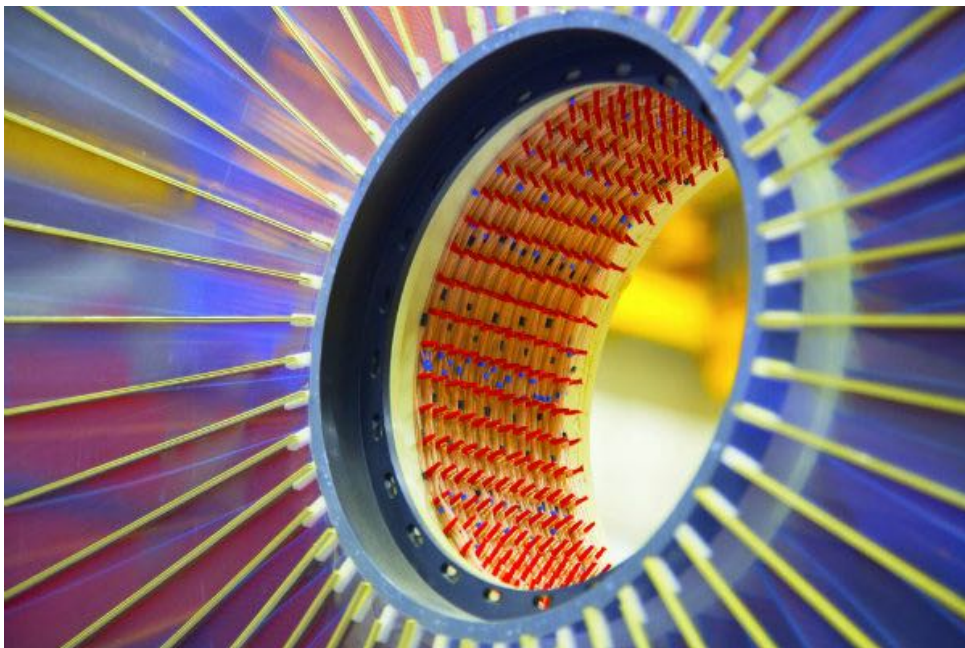


Michael Craddock
(1936 – 2015)

Michael Craddock
Award for Advanced
Students in
Accelerator Science



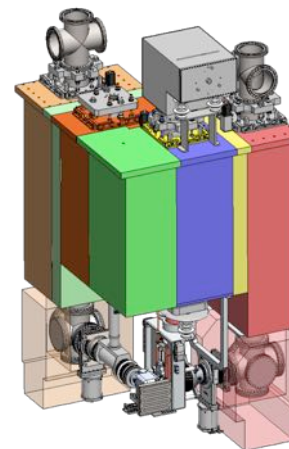
- Two major projects currently underway
 - ARIEL II
 - IAMI: Institute for Advanced Medical Isotopes



- Preliminary target design complete
- Funding announcement imminent
 - CFI, plus Alberta, British Columbia, Manitoba, Ontario, Quebec
- Operations model being developed
 - Three beams! Including ISAC ...



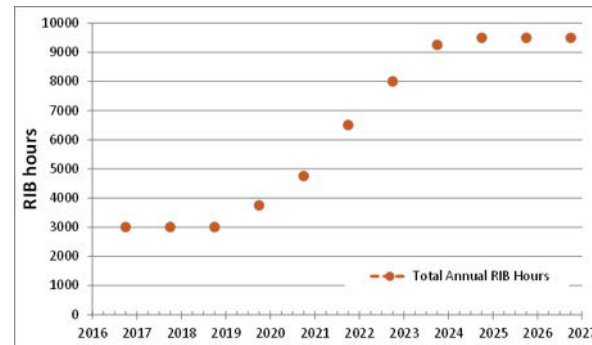
- Budget and scope now under change control
- Operation model defined – RIB “factory” with 3 week target cycle
- Electron target station conceptual design review completed
- RFP for 200 m Low Energy RIB lines released
- Preparing for Gate 2 Review of Phase I – September, 2016
- Resource action plan – 13 new term hires



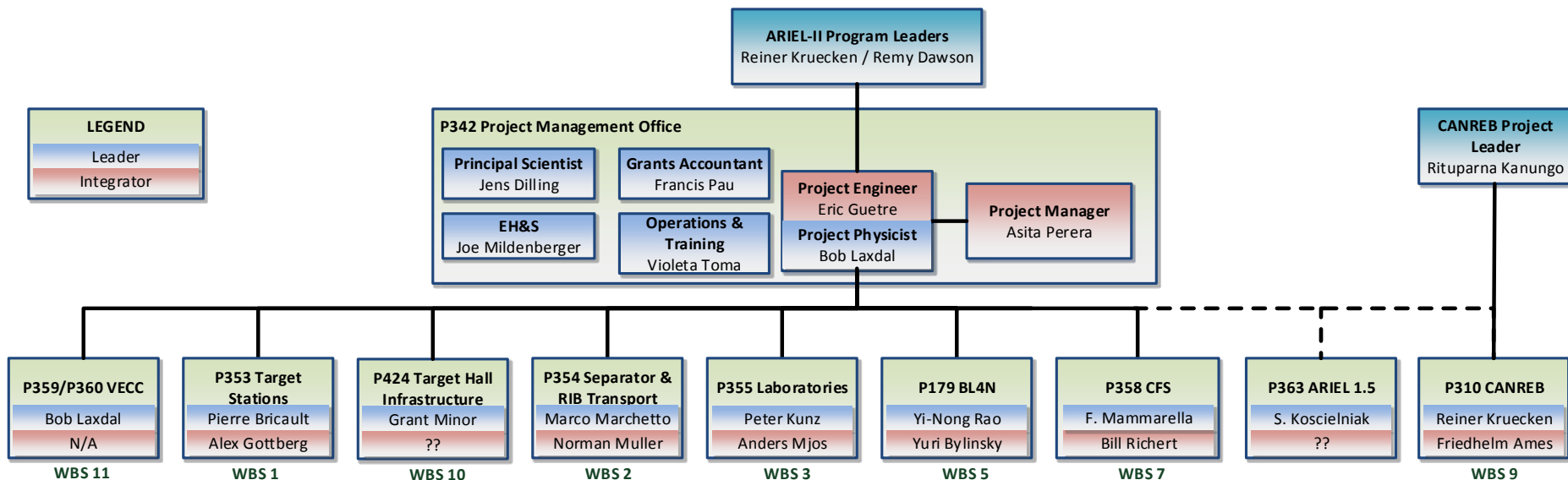
Electron target module

Week	Exchange
1	ITE
2	APTW
3	AETE
4	ITW
5	APTW
6	AETE
7	ITE
8	APTW
9	AETE
10	ITW
11	APTW

Target exchange schedule

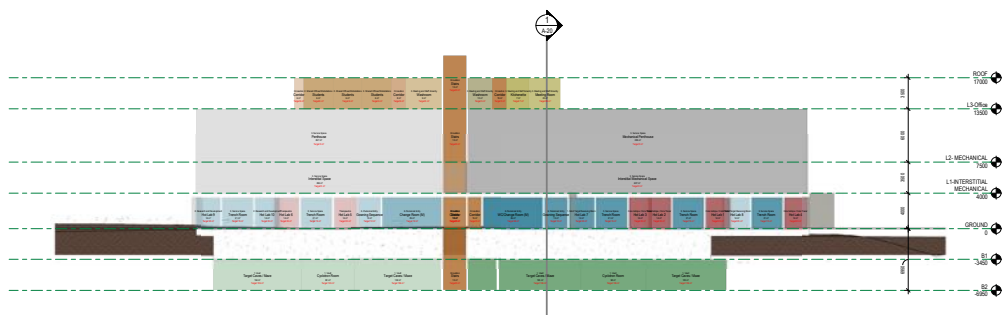
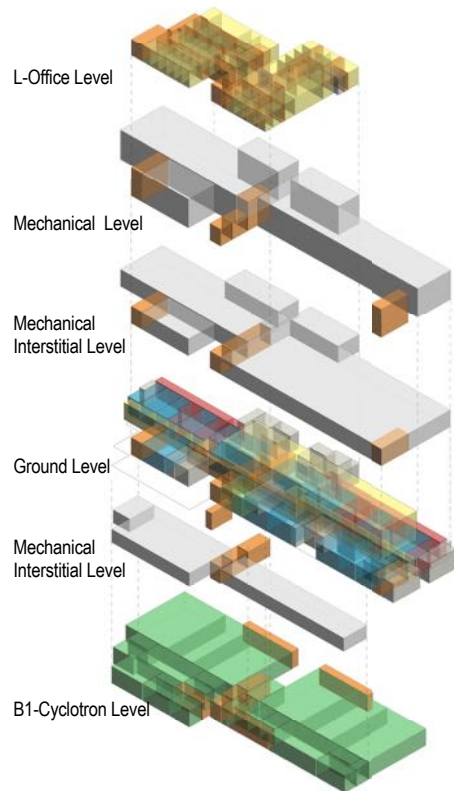


- Next steps include integrating Project Management Systems for ARIEL 1.5, ARIEL II, CANREB, and VECC MOU



- IAMI: Dual mission facility
 - Isotope production for British Columbia
 - Biomedical research for Canada
- Architectural design underway
 - Construction will begin when funding is secured
- TRIUMF in discussions with the federal and provincial governments
 - Funding being pursued through federal SIF program, with UBC's Faculty of Medicine





3 Option 5-displacement

1. Operate the laboratory safely and effectively
2. Produce world-class science
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- Budget 2016 expressed strong support for science and research and committed the government to a “comprehensive review of all elements of federal support for fundamental science over the coming year”



This review will “ensure there is sufficient flexibility to respond to emerging research opportunities for Canada, including big science projects and other international collaborations”

40th Anniversary of Commissioning



Feb 9, 1976



Feb 9, 2016

- In December 2015, TRIUMF and KEK signed an MOU to open branch offices at each other's institution
- Ceremony was hosted at the Canadian Embassy in Tokyo
- Office opened in May, 2016 by Hon. Kirsty Duncan, Minister of Science, in cooperation with IPP

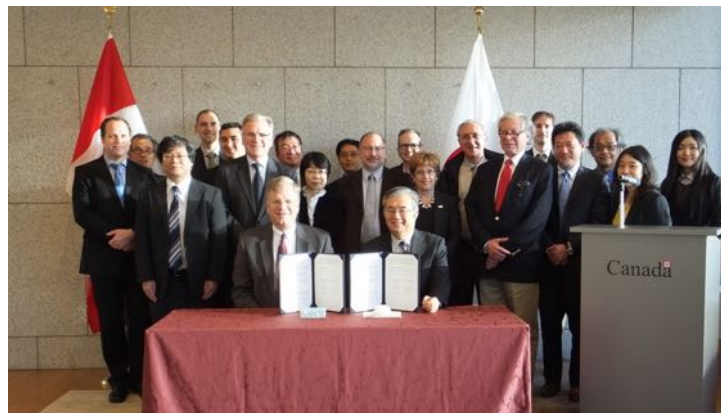
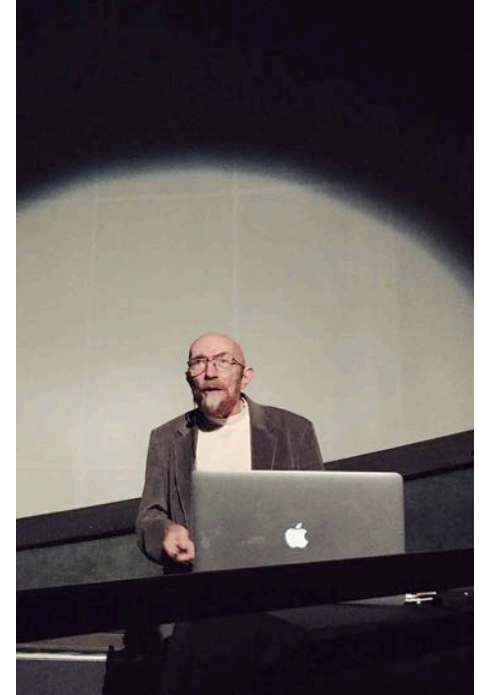




Photo Walk 2015



**Kip Thorne**

- Western Nuclear and Particle Physics Conference
 - Banff – February, 2016, 2017
- Progress in Ab Initio Techniques in Nuclear Physics
 - Vancouver – May, 2016
- Double Beta Decay Workshop
 - Vancouver – May, 2016
- Precision for New Discoveries
 - Vancouver – June, 2016
- TRISEP
 - Vancouver – June, 2016
- TRIUMF Science Week
 - Vancouver – July 18-22, 2016
- Direct Reactions with Exotic Beams
 - Halifax – July, 2016
- APS Division of Nuclear Physics Conference
 - Vancouver – October, 2016
- International Particle Accelerator Conference
 - Vancouver – April, 2018





Advanced Applied Physics Solutions

- Advanced Applied Physics Solutions (AAPS) has successfully exited from the Centre of Excellence for Commercialization and Research (CECR) program
- AAPS is now transitioning to become TRIUMF's business and commercialization company

ARTMS Products, Inc

- ARTMS manufactures targets to produce Tc-99m using medical cyclotrons
- The company is currently working with three investors:
 - Accel-Rx
 - Business Development Bank of Canada
 - UK-based radiopharmaceutical provider
- Health Canada Tc-99m clinical trials underway



CANADA'S
HEALTH SCIENCES
ACCELERATOR



- TRIUMF is a strong laboratory. It has a compelling mission, a clear vision and achievable goals. It is an organization of which our community should be proud
- With funding in place, TRIUMF is executing on its Five-Year Plan, and starting to prepare for the next
- TRIUMF is building the administrative capacity to ensure safe and effective operations for years to come

Send us your students!





Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

Thank you!
Merci!

TRIUMF: Alberta | British Columbia | Calgary |
Carleton | Guelph | McGill | Manitoba | McMaster |
Montréal | Northern British Columbia | Queen's |
Regina | Saint Mary's | Simon Fraser | Toronto |
Victoria | Western | Winnipeg | York

Follow us at TRIUMFLab

